Comment on "Learning to build the bomb"

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According to Alisa Carrigan's opinion in *Physics Today* Dec 2007 [1], to prevent proliferation of nuclear weapons, certain rules should be set to prevent the spread of a particular kind of knowledge. Her argument goes as follows: To build nuclear weapons, scientists and engineers of potentially rogue countries need to know some technics which could be learnt in nonmilitary peaceful activities, for example in nuclear power plants. Therefore, to prevent some countries access to nuclear weapon knowledge, one should prevent their scientists and engineers being trained in such facilities. As Carrigan says, *knowledge proliferation* is as important as nuclear proliferation. To show this, Carrigan mentions the case of South Africa's nuclear program—some scientists and engineers having trained in USA and Europe in non-military, peaceful, academic activities, obtained enough knowledge and expertise to make their own nuclear weapons. Carrigan says that the cases of North Korea, India, and Pakistan obtaining nuclear weapons, and Iran's progress in uranium enrichment are alike.

I would like to comment on this line of reasoning.

Logical consequences

First, nuclear weapons are not the only threats. Chemical and biological weapons are as dangerous as nuclear weapons. So if we accept this logic, the restriction should not be limited to nuclear physics and the related fields— by the same reasons, various fields in chemistry, chemical engineering, pharmaceutical and biological sciences, physics, and mechanics must be off-limits. After that comes various fields of mathematics, for example number theory, and software engineering; as they have applications in cryptography. Just think of a terrorist attack by some hacker to a computer that is controlling an airlines corridor traffic. Even quantum computation is also dangerous, because it has applications in deciphering. Where should one stop?

Carrigan distinguishes between explicit and tacit knowledge. But there is no permanent sharp line between explicit and tacit knowledge. For example, the need to use fabric gloves to assemble centrifuges, the problem mentioned in Carrigan's article, now that it is being published, has been transformed from tacit to explicit. Since people do have access to explicit knowledge, through books and journals, it is not sufficient to monitor the sources of tacit knowledge—to prevent proliferation of the required knowledge, it is necessary to control the flow of explicit knowledge as well. This requires establishing a system of censorship.

I think the logical consequence of accepting Carrigan's idea is a kind of "Knowledge Nonproliferation Treaty"—a system to monitor and control the flow of information through books, journals, internet, participation in conferences, sabbaticals, etc. Such a system, if implemented, simply means this: Humans are divided into two categories, those having the knowledge of making nuclear, chemical, and biological weapons, and those that have not yet this knowledge. The first category has the right and must do its best to prevent the second category obtaining the required knowledge and technology. At this limit, I think, it is nothing but a variant of apartheid.

An inevitable conclusion in line with Carrigan's arguments would be that good people should control other people in the sense that if other people were approaching dangerous knowledge (even by themselves), good people should prevent them even if necessary by force, even if necessary by getting rid of the scientists of other people and destroying their scientific facilities, including their libraries and equivalent digital resources. This, simply would force people in the second category—those who are forbidden to have the sacred knowledge—

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to invoke dirty tricks.

Scientific apartheid doesn't work

I am not saying that scientific apartheid is bad, for valuing something as good or bad could not be judged scientifically. What *is* important, I think, is that this scientific apartheid does not work, and is not a suitable means to establish a sustainable peace.

It does not work, because it is now almost impossible to impose it. Today, contrary to say 100 years ago, even people in developing countries do have access to the basics of the scientific method and the fundamentals of science. Once one knows these, it is in principle possible to produce the forbidden knowledge. After all, this is what scientists in the developed countries have done, and assuming that there is no meaningful distinction between the intelligence of people in different countries, if people in say USA have been able to learn or construct things by themselves, people in other countries can do that as well, though with some delay. So a Knowledge Nonproliferation Treaty does not help, since knowledge is not only transported, but also produced—the example of fabric gloves mentioned in Carrigan's article is a very good example of this.

Reducing tensions

Now let us consider this problem from another point of view. The case of South Africa's nuclear program is worthy of discussing. Why South Africa made weapons, and why finally destroyed its weapons? I think the answer is that, 4 decades ago South Africa was a country, having trouble with its neighbors—and its own people as well. After the Apartheid era, the troubles being solved, and now South Africa does not need any nuclear weapons. Which other countries have made nuclear weapons? North Korea, having trouble with South Korea; Israel, having trouble with all its neighbors; Pakistan, having trouble with India; India, trouble with Pakistan. What Carrigan points, is that all these nations were able to obtain the required knowledge, and all of them from non-military activities. What I conclude from this, is that if some nation has enough motivation to build a dangerous weapon, it probably can obtain the required knowledge—and Carrigan says that this has always been achieved by native scientists. *Now, if we want to make a sustainable peace, why not try to reduce the motivation of nations to have weapons?*

In mathematical terms

Let me formulate my view more mathematically. Let $K(T)$ be the probability of nation X to have the knowledge and technology required to produce a nuclear weapon before time T. Let $H(T)$ be the probability of nation X to have nuclear weapons before time T. And let $U(T)$ be the probability of nation X using nuclear weapons before time T. For time T let's consider 2020 for the moment.

One can argue that K is an increasing function of the level of ease physicists from X can visit foreign universities having nuclear physics departments. Denote this level of ease with x. One can also argue that H, and especially U depend critically on the regional tensions—by region I mean the Middle East, Kashmir, Korean Peninsula, etc. Let y denote the level of this tensions.

The most important task is to try to reduce U, and after that H. Carrigan is saying that K is an increasing function of x, even though so far all those nations who had enough motivation, have succeeded in obtaining nuclear weapons. What I am saying is that we know that decreasing y has quite profound effects on reducing H and U, and we know that in the only case for which the regional tensions vanished, the country (South Africa) destroyed its weapons. So why not trying to reduce the regional tensions?

Besides, $K(T)$ is obviously an increasing function of time T, because it is an increasing function of the overall level of knowledge and technology of the world. Day by day it will become more and more difficult to make K not approaching 1. However, for $H(T)$ and especially $U(T)$ it is not obvious that they are increasing functions of time, for they depend on the political conditions at times $t \leq T$. So again, it is quite wiser to try to reduce the regional tensions.

Finally, trying to reduce the level of knowledge of nation X, or preventing it from increasing its knowledge, by establishing a type of Knowledge Nonproliferation Treaty, will cause X to become more aggressive and less developed. I think both of these would increase $H(T)$ and $U(T)$.

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References

[1] Alisa L. Carrigan, "Learning to Build the Bomb", *Physics Today*, Dec 2007, pp. 54-55.